Using GIS to Build a Small Area Zonal System

Ying Zhou *, Kimberly Martin, Simon Choi
Southern California Association of Governments
* Primary Author, 213-236-1943. zhou@scag.ca.gov

Presented at the URISA CalGIS Conference, Huntington Beach, California, April 20, 2010

Abstract

The Southern California Association of Governments (SCAG) has been using GIS as an integral and indispensable tool as part of its future socioeconomic growth estimate and projection process.

All of SCAG's socioeconomic data is anchored to several thousand small geographical areas. The basic building block of this system is the U.S. Census block coverage. These form the basis for our smaller micro-parcel zone system as well as larger systems: the traffic analysis zones, sub regions, and, of key importance for a regional Council of Governments, cities.

One of the key challenges is keeping this system current between the decennial Censuses. The original boundaries quickly become out-dated due to city annexations and other political boundary changes. It is here where the power of a GIS plays a pivotal role. Its ability to overlay and integrate new boundary systems with older ones allows an efficient way of updating even the most complex zonal systems.

This paper will discuss how SCAG uses its GIS to update and maintain its various zonal systems so they are always current and accurate.

Background

The Southern California Association of Governments (SCAG) is the largest council of governments in the United States, and functions as the Metropolitan Planning Organization (MPO) for six counties (Los Angeles, Orange, San Bernardino, Riverside, Ventura, and Imperial) and 190 cities in Southern California. SCAG is charged with examining and helping to resolve short- and long-term issues impacting the region, particularly those related to transportation. The Region encompasses a population exceeding 19 million persons in an area of more than 38,000 square miles.

SCAG is mandated by the federal and state governments to develop regional plans for transportation, growth management, housing development, air quality and other issues of regional significance.

SCAG is responsible to produce socioeconomic growth for each round of Regional Transportation Planning (RTP). Further, SCAG produces socioeconomic estimates and projections at small area levels for each round of the RTP. The small area comprises combinations of county, city, Census tract, block and TAZ.

Figure1. SCAG Region

Challenges - changing boundaries

Any socioeconomic estimate and projection starts with a location. SCAG has been using the decennial census geographic information including its TIGER boundaries. SCAG started to build the socioeconomic data based on the table containing city/tract/block from the Census. As we moved farther away from the Census, the city boundaries that the Census carries gradually become out-dated. With the fast growing trends in some cities, there were a lot of annexations that occurred after 2000.

Most city boundary changes are through annexations, where an existing city extends its corporate boundaries. Not only annexations, but new cities also reshape the boundaries. In the SCAG region, there are nine new cities since the 2000 Census. (These are: Aliso Viejo, Laguna Hills, Laguna Woods, Rancho Santa Margarita city, Canyon Lake, Yucca Valley, Menifee, Wildomar, and the newest Eastvale in Riverside County)

Obliviously, the 2000 Census boundaries become obsolete as we develop the new round of socioeconomic growth.

Using GIS to create our zonal system – polygon to polygon

For each round of forecasting, we get updated city boundary shape files for different counties, reflecting current city boundaries. Meanwhile, we know that the tract/block relationship remains unchanged from the Census. The city boundary file is overlaid on top of the Tract/block. We get an updated set of city/tract/block, which is different from the Census; it reflects the city boundary changes.

Any polygon to polygon overlay will cause sliver issues; where the lines are not perfectly matching, it creates a zone that does not actually exist. We call them bogus zones. The more polygons you have, the greater chance of more bogus zones from the overlay/join process being created.

Obviously, we cannot build socioeconomic data on bogus zones. Before we do any estimates, we have to clean up these bogus zones.

To determine if the new zone is real-caused by annexation, or bogus-caused by sliver, we check these zones, if they are very tiny we believe they are bogus zones. For example, we look at the city/tract/block table. If there is a new city/tract/block zone, and we know there is no annexation in this city, yet the city/tract/block correspondence table is different from the Census, it's a bogus zone.

Cleaning up these bogus zones is a time consuming processing. After we carefully exam many silver cases, we believe there are still a lot of bogus zones carried in our system. What's more, because we only cleaned the file from the table, we do not have a shape file that matches the table.

We started to look at the centroid point method.

Point method

We convert tract/block to a point shape file, then we have the city boundary file overlay on top of the point file. After this join process, we get a set of city/tract/block tables that supposedly reflects annexations. Every point is nested into a city, no split, no sliver. But for some annexations, they split the blocks. With this centroid method, depending on the point location, the entire block either is assigned to the city or excluded from the city. It cannot capture the partial block annexations.

When two zonal systems need to be joined, the smaller the polygon of one zonal system is the better the point method works. Since parcel files are available in our organization, we introduce the parcel file which contains smaller polygons into our zonal system.

Getting Parcel file into the system

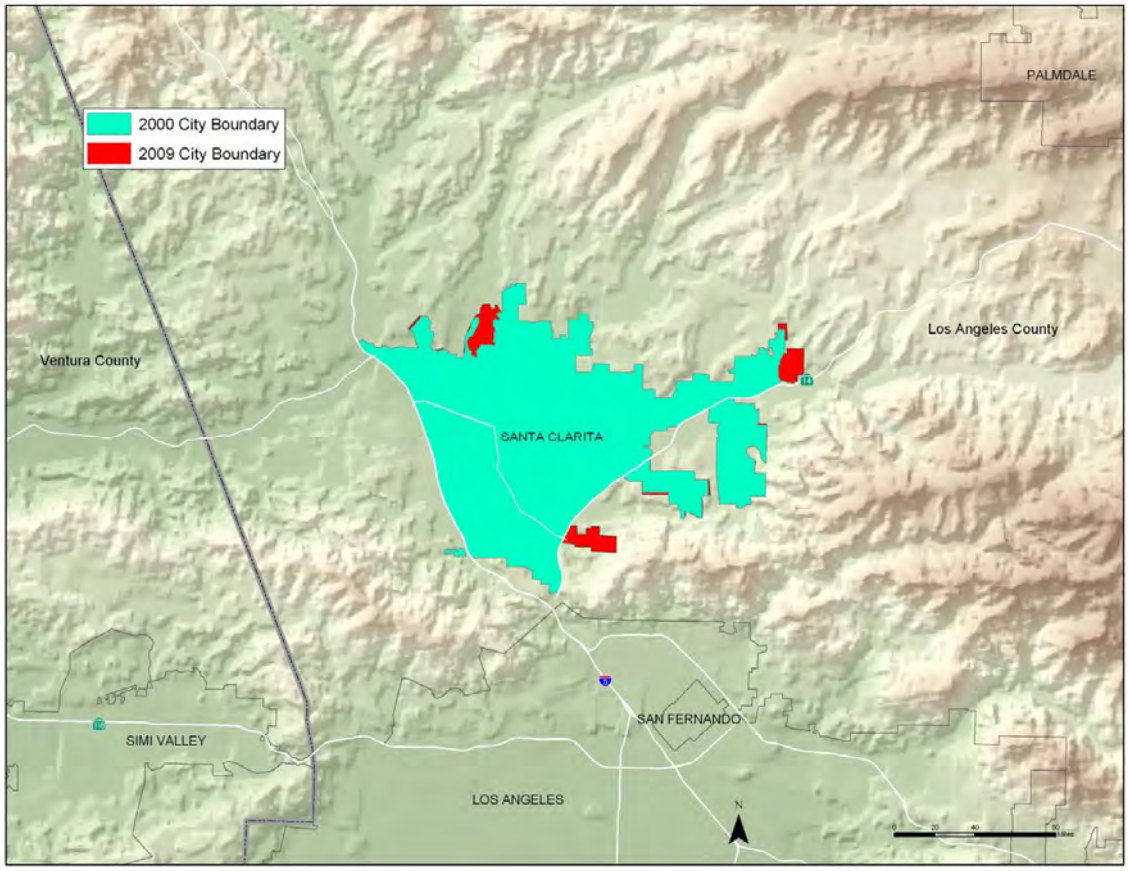
A parcel map is a given area, designed, drawn, and labeled for the purposes of identifying parcels and distinguishing them from one another in a given area. We join the parcel with tract/block. Then the tract/block/parcel file is converted to a point file and overlaid on a city boundary file. We know that when we have tract/block joined with parcel there are many slivers created as well. But there is an advantage of working with parcel files; they have the city attributions. We use an independent parcel/city file as a reference file to check against city/tract/block/parcel file. If the city assignment from city/tract/block/parcel file is different from the city/parcel attributions, we know the city/tract/block/parcel is a bogus zone. Having a parcel/city attribution file to help on cleaning bogus zones caused by sliver is a major improvement; it is more systematic.

We will use a case study to show how SCAG has been changing the method of using GIS to build a zonal system that captures the updated city boundary/annexations at detailed level.

A Case Study – Santa Clarita

Santa Clarita is a city located in northern Los Angeles County. It has gone through many annexations since the Census 2000. The following map illustrates the different boundaries of the city between the year 2000 and the year 2009.

Figure 2*. Santa Clarita City Boundary: 2000 vs. 2009

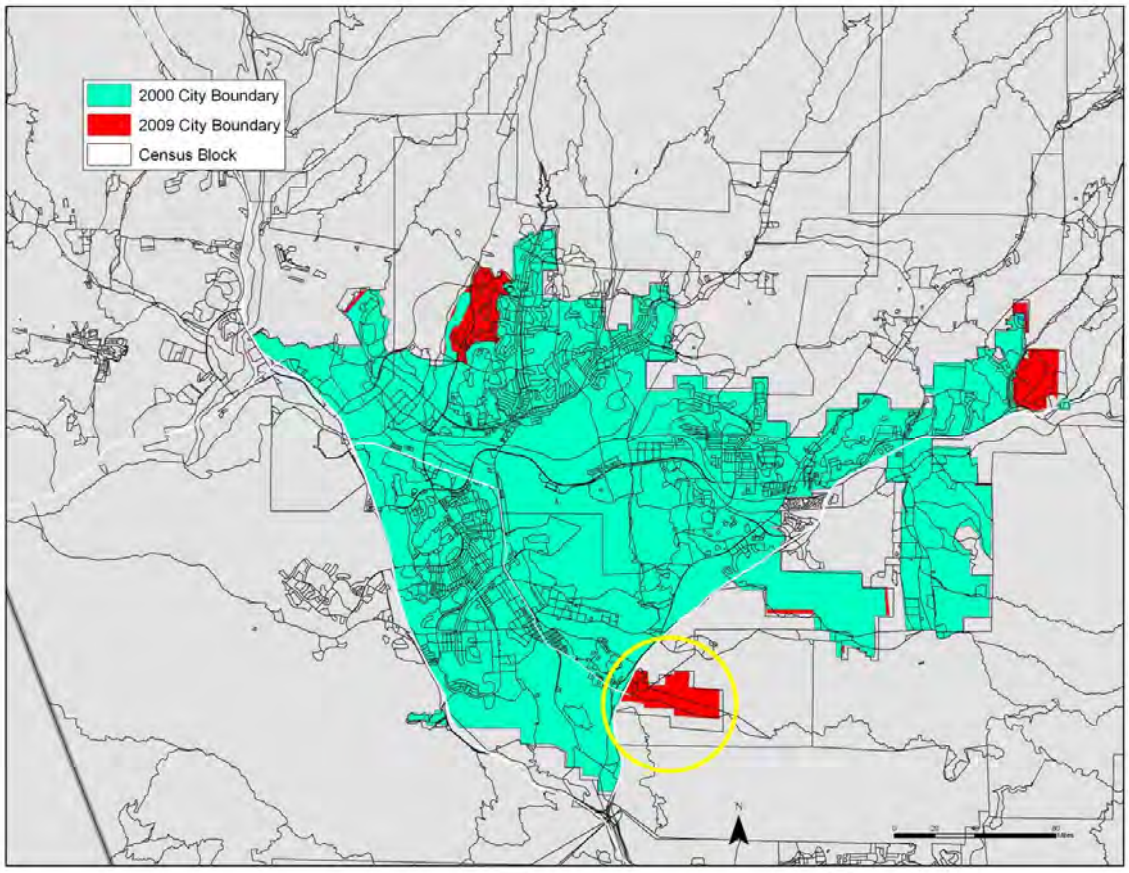


Note: * The Santa Clarita city boundary is from RTP12 city level boundary.

The red portion is the expansion of the city since the year 2000,

In order to identify what tract/block has been annexed to the city, we overlay the tract/block zonal map on top of the city boundary. The following map shows the result of the joining process.

Figure 3. Santa Clarita City: Overlaying of Tract/Block on its city boundary

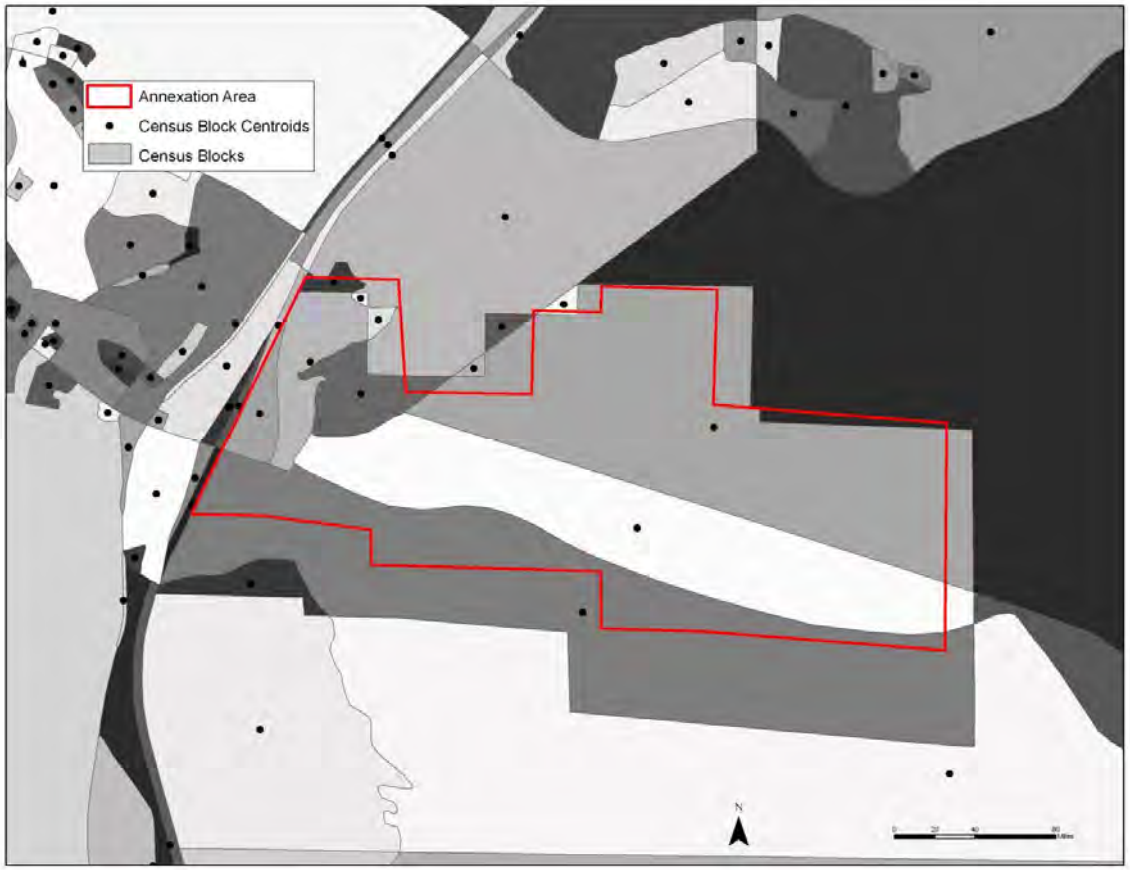


Further, the Figure 4 shows a blow-up of the lower right portion the city, circled above.

Figure 4. Santa Clarita City: Overlaying of Tract/Block on its city boundary, a blow-up version

The tract/block boundaries are not lined up together because the two boundary systems are from two difference sources. It creates bogus zones. In order to eliminate slivers we converted the tract/block to a point coverage then overlaid it on top of the city boundary, see the following map (Figure 5).

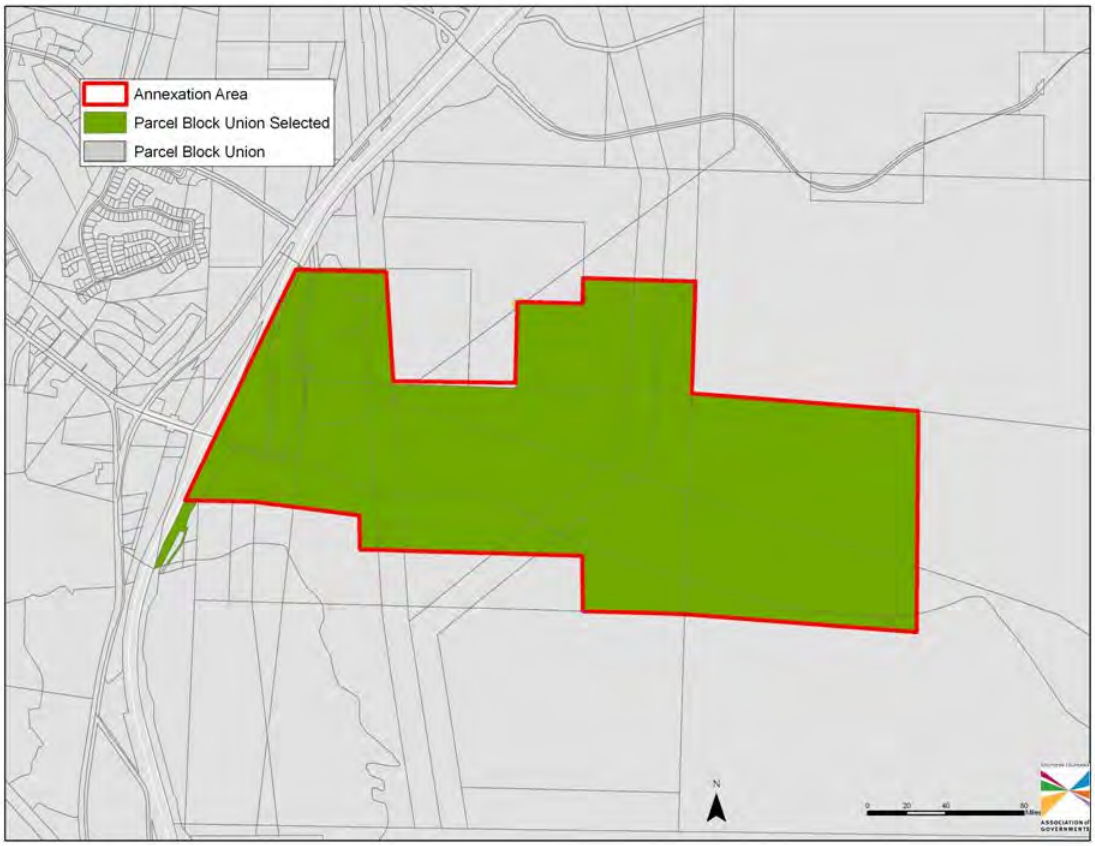
Figure 5. Conversion of the Tract/Block to Point Coverage



Each tract/block has one point, no slivers. But the problem is that if the partial block is annexed to the city, using a point method cannot reflect the partial block annexation. Depending on the point location, either the whole block is included or excluded in/from the city boundary. A better way to solve it is to cut the tract/block zone even smaller. SCAG has been making inroads to collect parcel files from all counties in the region. Even though parcel files could make our zonal system more complicated; the SCAG region is big, we want to utilize available data sources to improve the process of building our small area zonal system.

Figure 6 shows the joining result of parcel and tract/block.

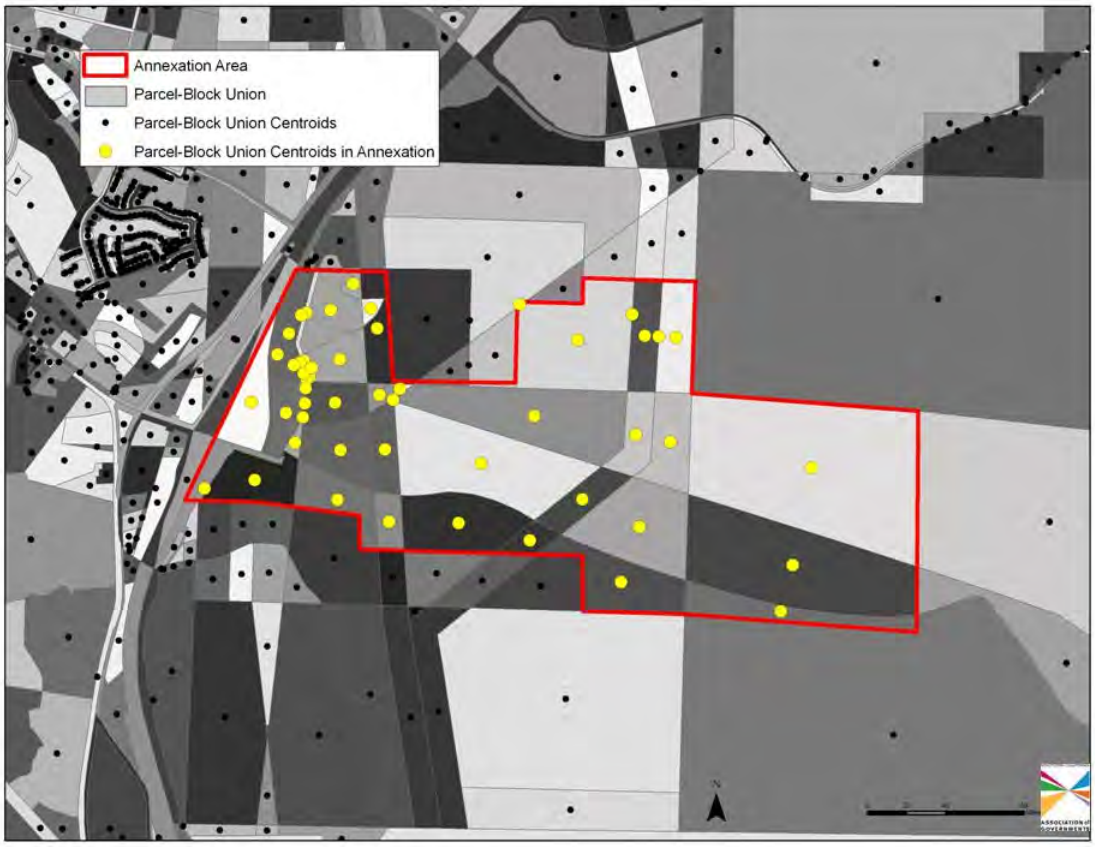
Figure 6. Santa Clarita City: Joining of Parcel and Tract/Block



The zone is much smaller and the number of the zones are greater after the overlay. Then we convert tract/block/parcel to point coverage and have it overlaid on top of the city/annexed area.

Figure 7 illustrates the result of the joining between point tract/block/parcel and the city/annexed area.

Figure 7. Santa Clarita City: Joining of Pint Tract/Block ant the City/Annexed Area



There are more points; the polygons are more accurately allocated into larger boundary than before.

Adding parcels into our zonal system not only makes our zonal system more detailed and accurate, but also helps us to make our socioeconomic growth forecast more accurate; parcels give us more detailed information such as land use type to guide our growth projections.

Conclusion

The changing city boundary issue requires us to use GIS technology to create our zonal system. As we encountered issues and problems, our method of creating the zonal system has been progressing and changing as well. It has been an on-going experience. The availability of detailed boundary files such as parcel files provides the possibility for us to think about and make improvements constantly.

We believe that we'll continue to encounter issues and problems with our zonal system. With GIS technology, we will always continue to think of ways to improve our small area zonal system.

About the Authors:

Ying Zhou, zhou@scag.ca.gov has been working in the small area growth forecasting field for the last twenty years. Recently she has been trying to integrate GIS more and more to the small area growth forecasting. She holds a Master Degree of Regional Planning from the University of Southern California.

Kimberly Martin, martink@scag.ca.gov is a Regional Planner at Southern California Association of Governments (SCAG), and works with GIS to convey long range transportation, land use, and housing goals to public officials and professional planners in the Southern California Region. Ms. Martin holds a MA in Urban Planning from UCLA and a BA in Political Science from UC Riverside.

Simon Choi, choi@scag.ca.gov is Program Manager of Data/GIS & Forecasting at the Southern California Association of Governments. He has worked in the field of urban and regional planning for nearly 30 years. He received his Master of City Planning from Seoul National University and Ph. D in Planning from the University of Southern California.